CENTRAL INTELLIGENCE AGENCY
INFORMATION FROM
FOREIGN DOCUMENTS OR RADIO BROADCASTS

REPORT
CD NO.

50X1-HUM

COUNTRY	USSR	DATE OF INFORMATION	1950
SUBJECT	Scientific - Chemistry (physical), lubricants		
HOW PUBLISHED	Thrice-monthly periodical	DATE DIST.	21 Dec 1950
WHERE PUBLISHED	Moscow-Leningrad	NO. OF PAGES	4
DATE PUBLISHED	21 Aug 1950		
LANGUAGE	Russian	SUPPLEMENT TO REPORT NO.	

THIS IS UNEVALUATED INFORMATION

SOURCE Doklady Akademii Nauk SSSR, Vol LXXIII, No 6, 1950, pp 1225-1228.

EFFECTS OF SURFACE ACTIVE SUBSTANCES ON THE FATIGUE OF STEEL

G. V. Karpenko
Presented by Acad A. I. Oparin
14 June 1950
Submitted 17 June 1950

/Numbers in parentheses refer to bibliography; figures referred to are appended./

The following represents the digest of a report on an extensive investigation establishing the dependence of the limit of fatigue strength of steel on: (a) the presence of surface active compounds in the lubricant; (b) the interplay of corrosion and of the effect of surface active compounds on the mechanical strength of steel; and (c) the frequency of stressing (the number of cyclical loads per minute) applied to the steel part.

The results obtained in this investigation will presumably influence work on lubricants in the USSR and the design and operation of engines and other mechanical appliances in that country.

It has been shown by P. A. Rebinder and his collaborators (1, 2) that the mechanical deformation and destruction of solid bodies is facilitated by the action of surface active compounds which lower the surface energy of the solid body and aid in the development of existing surface faults. In view of the fact that most machine parts work under cyclical stressing (cyclical loads) in the medium of surface active compounds (i.e., lubricating oils), the effect of surface active compounds on the fatigue strength of steel is of considerable practical interest. Being crystalline materials which have a random grain orientation, metals exhibit a variable surface resistance. Consequently, a study of the effect mentioned above could only be carried out by evaluating statistically the results of a great number of experiments. The investigation in question was started at the Dynamics Laboratory of the Institute of Structural Mechanics of the Ukrainian SSR as early as 1948.

STATE	X	NAVY	X	NSRB		DISTRIBUTION
ARMY	X	AIR	X	FBI		

The experiments were carried out on machines effecting pure bending in a symmetric cycle. Cylindrical samples of various steels were tested in a bath containing lubricants or other substances under investigation. Ten thousand, 3,000, 1,500, and 300 loadings per minute were applied. The results show that under cyclical stressing the fatigue strength of steel is considerably lowered by a surface active agent, but that the curve characterizing fatigue (Curve 3, Figure 1) has the same appearance as that resulting in the absence of a surface active agent (i.e., with the sample surrounded by air) in that a horizontal section of the curve develops (cf. Curve 1, Figure 1). The ordinate of the horizontal section of the curve indicates the fatigue limit δ_{-1}(3). No fatigue limit is observed in corroding media such as water or a sodium chloride solution. In other words, no horizontal section of the curve develops. Furthermore, in media causing corrosion, the fatigue strength drops as the number of loadings per unit of time increases. This can be seen, as far as water is concerned, in Curve 2, Figure 1.

Our experiments have shown that the addition of surface active compounds to media causing corrosion either completely inhibits corrosion or strongly reduces it. Thus, addition of isoamyl alcohol to water brings about a lowering of the fatigue limit, this being an effect produced by adsorption. At the same time, the curve develops a horizontal section indicating a fatigue limit. Furthermore, an increase of the number of loadings per unit of time does not increase the fatigue limit (cf. Figure 2).

We consider that this behavior is due to the passivating effect exerted by surface active agents (4). First, easing of deformation (a reduction of fatigue strength) takes place as a result of adsorption; then further easing of deformation is brought about by intercrystalline corrosion. The second effect is much weakened by the corrosion-inhibiting action of the surface active agent, however. In weakly corrosive media the second effect will be eliminated completely by the inhibiting action of the surface active agent, so that only a lowering of the fatigue limit due to adsorption will be observed (as, for instance, in the case of water containing 2% $C_5H_{11}OH$).

It appears from Figure 2 that 0.2% of isoamyl alcohol in distilled water produce a reduction by 42% of the fatigue limit in the case of hardened 40 Kh (chromium) steel. Increasing the concentration of isoamyl alcohol by a factor of 10 (to 2%) does not significantly change the fatigue limit. These results are of practical importance, because the majority of machine parts which are affected by fatigue of the material operate in the presence of lubricants containing a small quantity of surface active compounds.

Work done in our laboratory demonstrated that lubricating oils actually cause a lowering of the fatigue limit. The effect of lubricating oil on the fatigue limit of ground and polished samples of annealed 40 Kh steel is shown in Figure 3. Both fresh and used MS oil lowered the fatigue limit by the same value, namely 7.5%. Addition of 2% of oleic acid to the oil resulted under the same experimental conditions in a lowering of the fatigue limit by 19%. Furthermore, experiments carried out by us showed that castor oil brought about a lowering of the fatigue limit by 16% in the case of hardened 40 Kh steel of sorbitic structure.

In the light of the results outlined above, the necessity of testing steel parts in surface active media in which they actually operate, rather than in air, is apparent.

The frequency of loadings has practically no effect on the fatigue limit when the steel part operates in an inactive medium. On the other hand, the frequency of loadings exerts a marked effect in a surface active medium. Thus, at $n = 3,000$ loadings per minute MS lubricating oil lowered the fatigue limit of crude 20 Kh steel by 4%, while at $n = 300$ the corresponding reduction amounted to 6%. Water containing 2% of isoamyl alcohol at $n = 10,000$ lowered the fatigue limit of the same steel by 7%, while at $n = 3,000$ the reduction amounted to 30%. Inactive vaseline oil containing 2% of oleic acid had the following effects in lowering the fatigue limit of this steel: 5% at $n = 3,000$, 7% at $n = 1,500$.

It has thus been established that at greater frequencies of loadings, the effect on the fatigue strength produced by the addition of surface active compounds is reduced. When the frequency is high enough, addition of a surface active compound to the lubricating oil does not reduce the fatigue strength at all. This is the case at $n = 10,000$ with MS oil activated by 2% of $C_{17}H_{33}COOH$ and also with activated vaseline oil. At lower frequencies, the effect of surface active compounds under the same conditions is quite pronounced.

The explanation of the effect of frequency is that surface active compounds penetrate into microfissures of the sample's surface at a certain finite velocity. At high velocities of deformation, the time during which the microfissures are open will be so brief that the surface active agent will be unable to penetrate into them and contribute to the expansion of fissures.

Our experiments have shown that the lowering of the fatigue limit by surface active agents is greater with hardened steels than with viscous (crude) steels. The condition of the surface of the metal also has an influence, of course. We established that, in the case of crudely worked surfaces which exhibit a lot of surface roughness, the fatigue limit is reduced by surface active compounds to a much more limited extent than in the case of highly polished surfaces.

BIBLIOGRAPHY

1. P. A. Rebinder and V. I. Likhtman, Doklady Akademii Nauk SSSR, Vol LVI, p 723, 1947; P. A. Rebinder, Yubil. Sborn. AN SSSR (Jubilee Collection of Papers, Academy of Sciences USSR), 1, p 533, 1947.

2. V. I. Likhtman, Uspekhi Fizicheskikh Nauk, Vol XXXIX, No 3, 1949.

3. G. V. Karpenko, Doklady Akademii Nauk SSSR, No 3, 1949; G. V. Karpenko, ibid., No 6, 1949.

4. P. A. Rebinder and K. P. Rebinder, Zhurnal Fizicheskoy Khimii, 1, p 2, 1930.

[See figures on following page.]

Sanitized Copy Approved for Release 2011/07/22 : CIA-RDP80-00809A000600360973-2

CONFIDENTIAL

CONFIDENTIAL

50X1-HUM

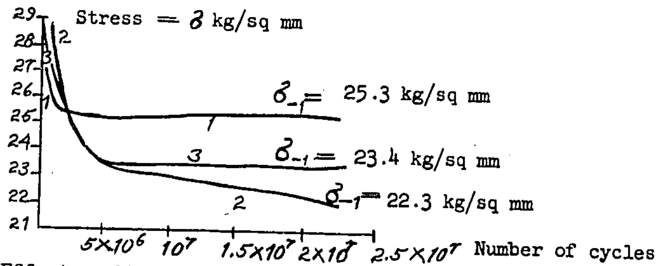

Figure 1. Effect on Steel Fatigue Strength of Surface Active Compounds Added to Medium Causing Corrosion

1 - in air; 2 - in water; 3 - in water containing 2% of isoamyl alcohol. Steel 20 Kh pearlite + ferrite. Surface polished. n = 10,000 loadings per minute

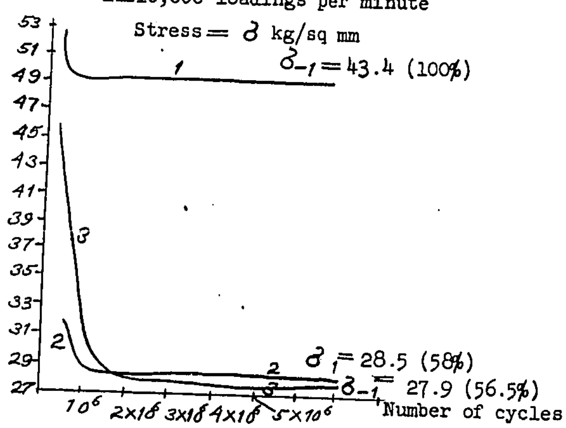

Figure 2. Effect of Concentration of Surface Active Compounds on Steel Fatigue Strength

1 - inactive medium (air); 2 - water containing 0.2% of isoamyl alcohol; 3 - water containing 2% of isoamyl alcohol. Steel 40 Kh, hardened and tempered; sorbite; machined on lathe (4th class). n = 2,840

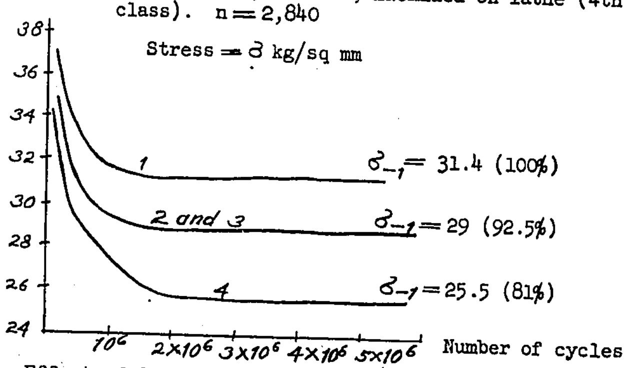

Figure 3. Effect of Oil on Fatigue Strength of Steel

1 - inactive medium (air); 2 - MS oil; 3 - used MS oil; 4 - MS oil containing 2% of oleic acid. Steel 40 Kh, hardened and annealed; pearlite + ferrite; polished (10th class). n=2,840

- E N D -

CONFIDENTIAL CONFIDENTIAL

Sanitized Copy Approved for Release 2011/07/22 : CIA-RDP80-00809A000600360973-2